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Chemistry: The Central Science

Article · January 2009

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Course Syllabus

NAME OF COURSE: AP Chemistry

GRADE(S): 10-12

LENGTH OF COURSE: full year

CREDITS: 6

COURSE DESCRIPTION:

AP Chemistry is designed to be the equivalent of a first year college general chemistry course. The class meets 6 periods per week with three single period sessions and two double period sessions for hands on lab experiences.

The course will place special emphasis on applying mathematics to problem solving and as a means of expressing and modeling scientific inquiry. The course will provide an in depth treatment of atomic structure, gas laws, thermodynamics, stoichiometry, kinetics, equilibria, oxidation-reduction and electrochemistry.

COURSE OBJECTIVES:

Develop students' problem solving skills

Provide laboratory experience that enables students to analyze collected data and arrive at logical conclusions

Give students background necessary to score well on the AP exam

Prepare students for additional courses in science

Develop students' ability for independent and logical thought

Increase students' ability to apply math to physical sciences

TEXTBOOK:

Kotz, John C. Treichel, Paul Chemistry and Chemical Reactivity
Saunders College Publishing

SUPPLEMENTARY INSTRUCTIONAL MATERIAL:

Author: Brown, Theodore
Second Author: Eugene, LeMay
Title: Chemistry the Central Science
Publisher: Prentice Hall
Description: supplemental textbook

Author: Chang, Raymond
Title: Chemistry 8th Edition
Publisher: McGraw-Hill
Description: supplemental text

Author: Zumdahl, Steven
Second Author: Susan, Zumdahl

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Title:Chemistry
Publisher:Houghton Mifflin
Published Date:2003
Description:supplemental textbook

Other Course Materials

Textbooks:

Material Type:Other
Description:Lab book:
Chemical Principals of the Laboratory 7th Edition
Slowinsky, Wolsey, Masterton
THomson Brooks/Cole

Material Type:Other
Description:Review Books:
Cracking the AP Chemistry Exam
Princeton Press, NY

Material Type:Other
Description:How to Prepare For The AP Chemistry Exam
Jespersen
Barrons Press, NY

Websites

URL:<http://apcentral.collegeboard.com/apc>
Description:The college board AP Chemistry site

URL:<http://www.sciencegeek.net/APChemistry>
Description:chapter by chapter overview of all the topics in the AP Chemistry curriculum, includes notes, worksheets, and interactive practice problems.

URL:<http://dbhs.wvusd.k12.ca.us/webdocs/chemTutorIndex>
Description:problems and tutorials for all segments of AP Chemistry

URL:<http://lrc-srvr.mps.ohio-state.edu/under/chemed/qb>
Description:A resource that includes all topics for the course with tutorials and quizzes

UNITS OF STUDY:

Unit Name or Timeframe:
1) Introduction. 1-2 weeks depending on students' assessed level of need to reinforce basic skills

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Content and/or Skills Taught:

Lecture will include chemical investigative methods, significant figures, accuracy and precision, dimensional analysis, gravimetric problem solving, data analysis, and variable relationships with graphing.

ESSENTIAL SKILLS:

- Describe and explain basic investigative methods in chemistry
- Analyze experimental results and arrive at logical conclusions
- Work comfortably with metric units to solve problems in dimensional analysis
- Use proper significant figures in data analysis
- Solve gravimetric problems

Major Assignments and/or Assessments:

- Lab Report: Accuracy and Precision
- Lab Report: Identity of an Unknown Substance (see resource appendix)
- Optional Labs: Paper Chromatography and Fractional Crystallization (lab book: Chemical Principles in the Laboratory)
- Homework assignments: Teacher selected from chapter 1 in the textbook
- Online: Students will go to <http://sciencegeek.net> to do the chapter 1 review and interactive problem sets
- Teacher created Unit 1 Test (30 MC and 4 OE)

Unit Name or Timeframe:

2) Atomic Theory. 1.5 weeks

Content and/or Skills Taught:

Lecture will include the development of atomic theory including, but not limited to, the experiments and theories of Dalton, Thomson, Millikan, Geiger, Mardsen , and Rutherford. Chemical formulas, mass percent, empirical and molecular formulas, and isotopes will be reviewed. Inorganic nomenclature and how to identify organic functional groups will be introduced.

ESSENTIAL SKILLS:

- Describe and explain the importance of the experiments that led to our modern understanding of the atom
- Describe electrons, protons, neutrons, and the general structure of the atom
- Explain the concepts of atomic number, atomic mass, and isotopes.
- Name simple inorganic compounds and identify organic functional groups.
- Calculate and differentiate between empirical and molecular formulas
- List the charges associated with common polyatomic ions
- Use the terminology of the periodic table- groups, periods, metal, nonmetal, metalloids etc.

Major Assignments and/or Assessments:

- Lab Report: Determination of the Chemical Formula and percent of Water in a Hydrate
- Homework: Teacher selected problems from the text chapter 2 review

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Online: Students go to <http://sciencegeek.net> to do the chapter 2 review and interactive problem sets

- Teacher created Unit 2 Test (20 MC and 6 OE)

Unit Name or Timeframe:

3) Chemical Reactions. 3.5 weeks.

Content and/or Skills Taught:

Lecture will include the mole and calculations using the quantity, equation balancing and an explanation of the information included in the chemical equation, stoichiometric calculation methods, information on limiting reagents and theoretical yields. Solutions should be addressed in detail.

ESSENTIAL SKILLS:

- Work problems involving moles
- Work problems involving solutions
- Explain the nature of ions in solution
- Define and use molarity in solution chemistry
- Balance equations
- Solve stoichiometric problems involving percent yield and limiting reagents
- Write chemical equations for the general types of reactions including synthesis, decomposition, single replacement, double replacement, and combustion, as well as the specific types oxidation-reduction and acid-base reactions
- Identify by inspection the category a reaction belongs in
- Use stoichiometry to analyze a mixture of compounds or to determine the formula of a compound

Major Assignments and/or Assessments:

- Lab Report: Gravimetric Analysis
- Lab Report: Solubility analyses
- Optional Lab Report: Synthesis of Alum
- Optional Lab Report: Stoichiometry: Job's Method
- Homework Assignments: Teacher selected from text chapters 3 to 5 review
- Online: Students will go to <http://sciencegeek.net> to do the chapter 3 to 5 review and interactive problem sets
- Teacher created Unit 3 Test (20 MC and 8 OE)

Unit Name or Timeframe:

4) Energy in Chemical Reactions. 2 weeks.

Content and/or Skills Taught:

Lecture will include the 3 laws of thermodynamics and their implications. Conservation of energy, temperature, and heat will be introduced. Specific heat capacity theory and problems will be done and applied to first law problem solutions. The concepts of enthalpy and entropy changes will be discussed. Hess's Law and the terms heat of reaction and heat of formation will be explained.

ESSENTIAL SKILLS:

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- Define the various forms of energy and the nature of heat flow
- Use and explain the terms enthalpy, entropy, heat of reaction, heat of formation, calorimetry, joule, calorie, BTU, system, and surroundings
- Solve calorimetry problems
- Apply and understand the zeroth, first, and second laws of thermodynamics
- Define and understand the state functions enthalpy and internal energy
- Apply Hess's Law
- Show how to draw and interpret energy diagrams

Major Assignments and/or Assessments:

- Lab Report: Calorimetry
- Lab Report: Hess's Law
- Online: Students go to <http://sciencegeek.net> to do the chapter 6 review and interactive problem sets
- Teacher created Unit 4 Test (20 MC and 8 OE)

Unit Name or Timeframe:

5) Atomic Structure. 2 weeks.

Content and/or Skills Taught:

Lecture will include a description of wave behavior and an emphasis on electromagnetic waves. The work of Einstein, de Broglie, Bohr, Heisenberg, Planck, and Schrodinger should be discussed in some detail. Atomic spectra will be explained as well as reference to the Balmer, Paschen, Brackett, and Pfund series. Quantum numbers are introduced as well as their application to writing electron configurations.

ESSENTIAL SKILLS:

- Use and understand the terms frequency, wavelength, amplitude, and node. Be able to solve problems of the form $\text{velocity} = \text{frequency} \times \text{wavelength}$.
- Solve problems involving Planck's relationship between energy and frequency
- Describe the Bohr model of the atom
- Explain and use quantum numbers
- Explain and solve equations using the Heisenberg Uncertainty Principle
- Work problems involving electron energy transitions
- Explain the Pauli exclusion principle and Hund's rule
- Write electron configurations

Major Assignments and/or Assessments:

- Lab Report: Atomic Spectra of Hydrogen
- Homework Assignments: Teacher selected from text chapter 7 review
- Online: Students will go to <http://sciencegeek.net> to do the chapter 7 review and interactive problem sets
- Group Work: Atomic Spectra lab
- Teacher created Unit 5 Test (20 MC and 8 OE)

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Unit Name or Timeframe:

6) Electron Configurations and Chemical Periodicity. 1.5 weeks.

Content and/or Skills Taught:

- Lecture will include a history of the development of the modern periodic table. The concept of electron spin and magnetic effects will be explained. Periodic trends will be addressed in detail including graphs showing periodic tendencies. The ideas of shielding and effective nuclear charge will be discussed.

ESSENTIAL SKILLS:

- Understand the basis for the periodic law and apply it to periodic properties such as atomic radii, ionization energy, electron affinity, density, melting point, and oxidation states
- Understand electron spin and how magnetism influences atom properties
- Understand the concept of effective nuclear charge

Major Assignments and/or Assessments:

- Lab Report: Periodic Behavior
- Group Work: Periodic Properties Lab
- Homework Assignments: Teacher selected from text chapter 8 review
- Online: Students will go to <http://sciencegeek.net> to do the chapter 8 review and interactive problem sets
- Teacher created Unit 5 Test (20 MC and 8 OE)

Unit Name or Timeframe:

7)Chemical Bonding. 2 weeks.

Content and/or Skills Taught:

Lecture will include ionic bond calculation and covalent bonding. Lewis structures will be explained and practiced. Bond polarities will be discussed along with their effect on molecular behavior. Students will be exposed to VSEPR theory and the molecule shapes driven by it. The ideas of hybrid orbitals and molecular orbital theory will be introduced.

ESSENTIAL SKILLS:

- Explain what constitutes ionic and covalent bonds
- Explain the intermolecular forces and the reasons they exist
- Explain how polarity arises in a molecule
- Be able to do Lewis dot structures for molecules
- Apply VSEPR
- Explain the meaning of hybrid orbitals and the molecules that contain them
- Explain Molecular orbital theory
- Be able to predict the geometric shape of molecules

Major Assignments and/or Assessments:

- Lab Report: Molecular Models
- Lab Report: Classification of Substances by Type of Bonding

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- Homework Assignments: Teacher selected from text chapter 9-11 review
- Online: Students will go to <http://sciencegeek.net> to do the chapter 9-11 reviews and interactive problem sets
- Teacher created Unit 5 Test (20 MC and 8 OE)

Unit Name or Timeframe:

8) States of Matter. 4 weeks.

Content and/or Skills Taught:

Lecture will include a thorough treatment of gas laws including the van der Waals equation. Application of the gas laws to stoichiometric problems will be shown. Kinetic molecular theory will be introduced especially the distribution of molecular speeds. The properties of liquids and solids will be discussed with most time spent on the liquid properties. Instruction will be given on generating and reading phase diagrams and the Clausius-Clapeyron equation will be used since it connects temperature, vapor pressure, and enthalpy of vaporization.

ESSENTIAL SKILLS:

- Describe the general characteristics of the states of matter
- Work gas law problems
- State and understand kinetic molecular theory
- Apply kinetic molecular theory to liquids and solids as well as gases
- Draw and understand phase diagrams
- Work problems involving molarity, molality, mole fraction, and normality
- Explain and be able to calculate colligative effects
- Explain the van der Waals corrections for a non-ideal gas
- Explain the factors affecting vapor pressure
- Be able to work Henry's Law problems
- Work problems with Raoult's Law
- Work problems using the Clausius-Clapeyron equation

Major Assignments and/or Assessments:

- Teacher created Unit 8 Test (20 MC and 8 OE) This is a large unit and so depending on the student group it may be desirable to split the unit into 2 tests, one on gas laws, the remainder in a second test
- Lab Report: Boyle's Law
- Lab Report: Molar Mass of a Volatile Liquid
- Lab Report: Vapor Pressure and Heat of Vaporization of a Liquid
- Lab Report: Molecular Weight by Freezing Point Depression
- Homework: teacher selects questions from the chapter 12-14 review to grade and assigns selected online quizzes

Unit Name or Timeframe:

9) Kinetics. 2.5 weeks

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Content and/or Skills Taught:

Lecture will include an overview of how we find rates of reaction from experimental data followed by how conditions affect those rates. Methods for determining the rate equation should be presented with special emphasis on -1, 0, 1st, and 2nd order equations. It is worthwhile to introduce the calculus here along with the graphical relationships. A number of rate problems should be done for the students. The Arrhenius equation and its uses should be dealt with in some detail. Finally reaction mechanisms should be explained.

ESSENTIAL SKILLS:

- Explain rates of reaction and the conditions affecting rates
- Be able to derive average and instantaneous rates from experimental data
- Derive the rate equation, rate constant, and reaction order from the experimental data
- Use integrated rate laws
- Understand the collision theory and activation energy
- Use the Arrhenius equation
- Be able to relate reaction mechanisms and rate laws
- Understand and be able to draw reaction coordination diagrams
- Understand the function of a catalyst and the effect on the reaction mechanism and activation energy.

Major Assignments and/or Assessments:

- Teacher created Unit 9 Test (20 MC and 8 OE)
- Lab Report: Rate and Order of Reaction
- Optional Lab Report: The Iodination of Acetone
- Homework: teacher selects questions from the chapter 15 review to grade and assigns selected online quizzes

Unit Name or Timeframe:

10) Equilibrium. 2.5 weeks.

Content and/or Skills Taught:

Lecture will include the concept of dynamic equilibrium including Le Chatelier's Principle. The meaning of the equilibrium constant and the reaction quotient are introduced as well as methods for solving equilibrium systems problems. Thermodynamics should be reintroduced here so that students can understand the relationship between the Gibb's Free Energy and K.

ESSENTIAL SKILLS:

- Explain the nature and characteristics of chemical equilibria
- Explain the reaction quotient Q and the equilibrium constant K
- Recognize the states that belong in the equilibrium expression
- Realize the different ways we can express equilibrium quantities
- Use reaction quotient to decide how a reaction will or will not proceed
- Calculate the equilibrium constant

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- List and explain the factors that influence K
- Explain how to use Le Chatelier's Principle to predict the effect of disturbance of an equilibrium system
- Show how the Gibbs Free Energy relates to the equilibrium constant
- Distinguish the various forms of K (K_{sp} , K_a , K_b)
- Work problems involving K_{sp}

Major Assignments and/or Assessments:

- Teacher created Unit 10 Test (20 MC and 8 OE)
- Lab Report: Determination of the Equilibrium Constant
- Lab Report: K_{sp} $\text{Ca}(\text{OH})_2$
- Homework: teacher selects questions from the chapter 16,19 and 20 reviews to grade and assigns selected online quizzes

Unit Name or Timeframe:

11) Chemical Thermodynamics 1.5 weeks

Content and/or Skills Taught:

Lecture will include laws of thermodynamics, relationship between spontaneity and direction in a chemical process, entropy as a state function, spontaneity in the reverse direction, or in equilibrium; relationship between changes in Gibbs free energy and the equilibrium constant

ESSENTIAL SKILLS:

Calculate changes in entropy

Identify whether processes are spontaneous as described

Define Gibbs free energy and calculate changes in free energy for given processes

Determine the effect of temperature on spontaneity

Describe the relationship between changes in free energy and the equilibrium constant

Major Assignments and/or Assessments:

Teacher created Unit 11 Test (20 MC and 8 OE)

Lab Report: Entropy and Microstates

Homework: teacher selects questions from the chapter 19 reviews to grade and assigns selected online quizzes

Unit Name or Timeframe:

12) Acids and Bases. 2.5 weeks.

Content and/or Skills Taught:

Lecture will include Arrhenius, Bronsted-Lowry, and Lewis acid base theories. The concepts of K_a and K_b will be tied to the previous unit and students will realize that the problems are identical in format.

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Titration will be introduced and a number of problems should be presented. Buffer preparation and buffer calculations should be done using the Henderson-Hasselbalch equation.

ESSENTIAL SKILLS OUTCOMES

- State and distinguish the 3 acid-base definitions Arrhenius, Lewis, and Bronsted-Lowry
- Correctly use the terminology amphiprotic and autoionization
- Identify common strong acids and bases
- Understand the pH and pOH scales and solve problems with them
- Write equilibrium expressions for weak acids and bases
- Solve acid-base equilibrium problems
- Calculate pK_a and pK_b
- Predict the outcome of acid-base reactions
- Use the Henderson-Hasselbalch Equation
- Show how to prepare a buffer solution
- Find pH at equivalence point of a titration
- Describe the function of an indicator

Major Assignments and/or Assessments:

- Teacher created Unit 11 Test (20 MC and 8 OE)
- Lab Report: Titration of a Diprotic Acid
- Lab Report: Identification of a Solid Organic Acid
- Optional Lab Report: K value of an Indicator
- Optional Lab Report: Preparation of a Buffer
- Homework: teacher selects questions from the chapters 17-18 review to grade and assigns selected online quizzes

Unit Name or Timeframe:

13) Oxidation, Reduction and Electrochemistry. 2 weeks.

Content and/or Skills Taught:

Lecture will include a review of balancing redox reactions. The principles underlying voltaic cells will be introduced and the half-cells and potentials will be introduced. The relationship between voltage and concentration will be discussed and problems involving the Nernst Equation will be solved. The concept of electrolysis will be covered as well as a revisiting of the Gibbs Free Energy as it relates to cell voltage.

ESSENTIAL SKILLS:

- Balance redox reactions
- Construct and diagram voltaic cells
- Understand and calculate electrochemical potentials
- Use the Nernst equation to solve problems
- Explain the relationship between voltage and Gibbs Free Energy

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Major Assignments and/or Assessments:

- Teacher created Unit 12 Test (20 MC and 8 OE)
- Lab Report: Electrochemistry
- Optional Lab Report: Determination of Iron by Reaction with Permanganate
- Optional Lab Report: Equivalent Mass by Electrolysis
- Homework: teacher selects questions from the chapter 21 review to grade and assigns selected online quizzes

Unit Name or Timeframe:

14) AP Exam Review. 2-3 weeks.

Content and/or Skills Taught:

This unit will help students prepare for the approaching AP Chemistry Exam. Strategies on test taking as well as concentrated work and review of previous AP questions will be the majority of our efforts.

- Practice AP questions from the AP central web site for the free response section of the exam
- Practice multiple choice and free response questions from review books in the resources section
- Solve a number of AP style problems
- Score a 3 or higher on the practice AP exams

Major Assignments and/or Assessments:

- Practice AP exams from review books and AP Central web site
- Final exam
- Actual AP Exam scores

PROFICIENCIES:

See above by unit under ESSENTIAL SKILLS

FIELD TRIPS & GUEST SPEAKERS:

As appropriate
Chemistry Olympics

EVALUATION AND ASSESSMENT: *Description and method of evaluation for each component noted below.*

- **Tests and Quizzes: 80%**
- **Homework, Class Participation, Laboratory and Projects – 20%**

NEW JERSEY CORE CURRICULUM CONTENT STANDARD ALIGNMENT:

5.1.12.A1-3,
5.1.12.B1-4
5.1.12.C1-3,

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5.1.12 D2
5.2.12. A1-6
5.2.12. B1-3
5.2.12. C1-2
5.2.12. D2-5